CHAPTER 11

Data Link Control and Protocols

Review Questions

1. Flow control prevents the receiving device from being overwhelmed with data.
2. Three popular ARQ mechanisms are Stop and Wait ARQ, Go-Back-N ARQ, and Selective Repeat ARQ.
3. The frame is re-transmitted.
4. S is a variable at the sender end that holds the number of the recently sent frame. R is a variable at the receiver end that holds the number of the next frame expected.
5. In Selective Repeat ARQ, just the damaged frame is re-transmitted. In Go-Back-N ARQ, all frames starting with the damaged frame are re-transmitted.
6. The sender sets a timer when a frame is sent. If an acknowledgment is not received by the time the timer expires, the frame is re-transmitted.
7. At the sender site the window size is at most 2^m - 1. At the receiver site the window size is always 1.
8. In Go-Back-N ARQ, if a frame is lost, the sender's timer expires and the sender re-sends that frame and any succeeding frames. In Selective Repeat ARQ, if a frame is lost, the sender's timer expires and the sender re-sends that frame only. In both ARQs, if an ACK is lost and the next ACK is received before the timer expires, there is no re-transmission. If the timer expires before the next ACK is received, there is re-transmission.
9. Both the sender site window and the receiver site window are at most one-half of 2^m.
10. Go-Back-N ARQ and Selective Repeat ARQ.
11. The bandwidth delay product is a measure of the number of bits that can be sent out while waiting for news from the receiver.
12. Bit stuffing is the process of adding one extra 0 when there are five consecutive 1s in the data stream to distinguish data from a flag.

13. I-frames are used to transport user data and related control information. S-frames carry control information (data link flow and error control). U-frames are used to transport system management information.

14. The first one or two bits identify the frame. The N(S) bits define the sequence number of the frame. The N(R) bits define the acknowledgment number. One field in the S-frame and two fields of the U-frame define the type of the corresponding frames. In all of types of frames a P/F bit defines the direction of the frame.

15. Piggybacking is combining data to be sent and acknowledgment of the received frame in one single frame.

16. RR, RNR, REJ, SREJ.

Multiple-Choice Questions

17. a
18. c
19. d
20. c
21. b
22. b
23. a
24. a
25. b
26. b
27. a
28. a
29. b
30. a

Exercises

31. See Figure 11.1.
32. See Figure 11.2
33. The number refers to the damaged frame; only that frame should be resent.
34. The number refers to the next expected frame.
35.
    a. Frames 7 and 0 received; next frame expected is frame 1
    b. Frames 7, 0, 1, 2, and 3 received; next frame expected is frame 4
    c. Frames 7, 0, 1, 2 received; the next frame expected is frame 3
36. Four bits. Sequence numbers are from **0** (0000 in binary) to **15** (1111 in binary). In other words, the number of bits are $\log_2 16 = 4$
37. 127.
38. 0, 1, 2, 3, 4, 5, 6, 7, 0, 1, 2, 3, 4, 5, 6, 7, 0, 1, 2, 3, 4, 5, 6, 7, 0, 1, 2
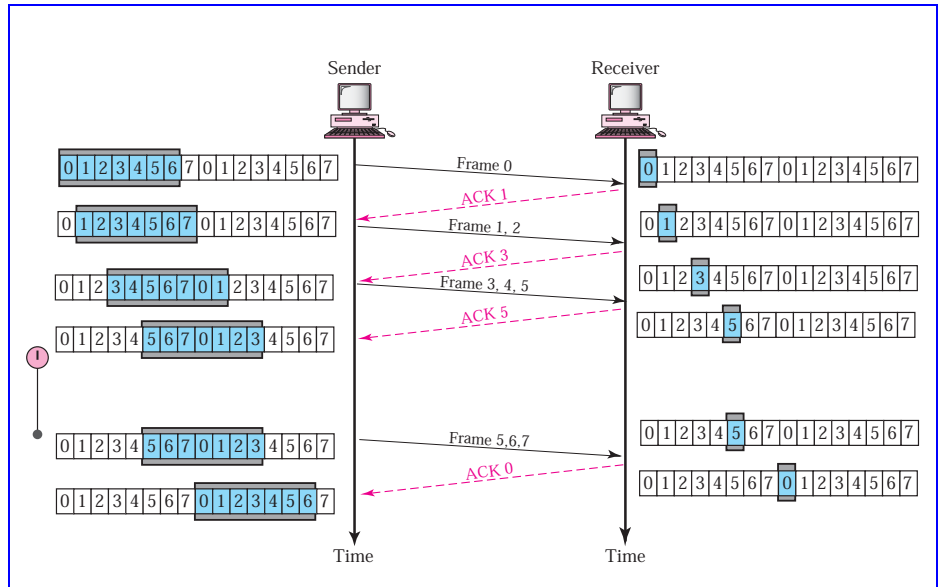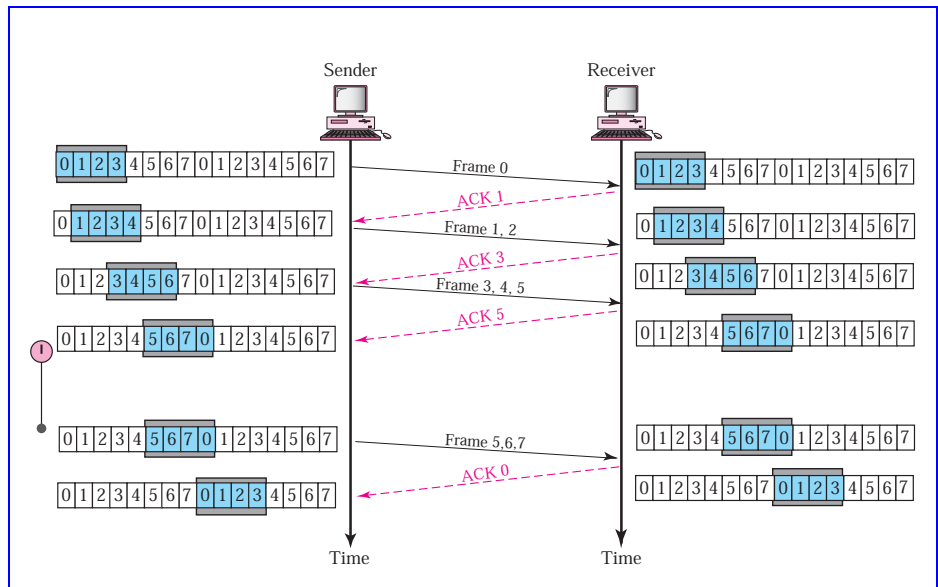
Figure 11.1 *Exercise 31*

Figure 11.2 *Exercise 32*

39. Window size is 15.
40. 26 ms
41. 80 μs
42. 26 ms
43. less than 6 ms

44. ⇐ 000111110101111000111100111110001
45. ⇐ 0001111101111101111101111101111101111100111110001